E X A D A T

A NEW EXPLOSIVES ACCIDENT DATABASE

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Abstract:

Thorough knowledge about accidents which already have happened is a decisive requirement for a realistic assessment of the safety of explosives and ammunition handling. Especially for probabilistic assessments the causes of fires and explosions, the frequency of such events and the damages in the surroundings are of main interest. In Switzerland, where the explosives safety in the military field is judged completely based on quantitative risk basis, respective accident reports have been collected for years. The library of Bienz, Kummer & Partner Ltd. (BK&P) contains reports and information on about 7'000 to 10'000 explosives accidents having happened around the world. As the management and the application of this enormous amount of information for actual risk analysis being time-consuming, BK&P and the Swiss DoD Technology and Procurement Agency are developing in a joint venture a database called EXADAT.

This paper describes the explosives accident database EXADAT, the basic capabilities are explained and the state of work as well as future improvements and extensions are presented. Furthermore, details are given about the source of information.

Contents:

Paper presented at the 27th Department of Defense Explosives Safety Seminar in Las Vegas NV, USA on 20 - 22 August 1996

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1. Background

In Switzerland, with its limited land and financial resources, the safety assessment of ammunition and explosives handling has successfully been based on a quantitative risk approach for many years. According to the Swiss DoD safety regulations, a quantitative risk analysis has to be performed for the safety evaluation of every new operation, manufacturing plant or storage facility [Ref. 1, 2].

To perform a probabilistic risk analysis you need - compared to applying a quantity distance concept - not only better qualified and trained personnel but also much more technical data. You may have to answer questions like:

- What are probable causes of an accident?
- How often is the accident going to happen?
- What will the damage to the surrounding be?
- Has ever happened an accident with substance X?

In addition to data from tests and expert judgement, thorough knowledge of accidents which already have happened is a decisive instrument to answer this kind of questions. Particularly when it comes to the estimation of probabilities, statistics of such accidents are of major help [Ref. 3].

This is the reason why we started to collect related accident reports long ago. Up to now, the data file of Bienz, Kummer & Partner has grown to more than 12'000 accidents with hazardous goods from all over the world. Alone 7'000 to 10'000 reports concern accidents and incidents with explosives. As the manual handling of such a huge file is a tedious and time consuming work, recently the Swiss DoD Technology and Procurement Agency and Bienz, Kummer & Partner decided to develop in a joint-venture an easy to use database.

2. Why a new Database ?

Probably you wonder why we decided to take so much money in our hands to develop our own database, and argue that many commercially available databases in this field exist already. However, an inquiry showed that the existing databases do not cover the field of explosives very well. Many of this databases are focused on accidents in the chemical and petrochemical industry like the database FACTS (TNO, Netherlands) or only cover major accidents like MHIDAS (Major Hazard Incident Data Service, UK). Other commercially available software do not contain enough information to really support the risk analyst in the decision he has to make (see example in fig. 1). One of the greatest disadvantage of other databases is the fact that they are not directly available for the risk analyst. That means, the database is not commercially sold and you have to ask an organisation or a company to perform a search in the database for you. You need to have the data on your own PC

Example of a "No Name" Data Base File

```
  Serialnum 751001
       Year 1975
     Month1 10
       Day1 01
     Month2
       Day2
   Location M cM asterville  (near Montreal), Quebec
      State
    Country Canada
   Activity Fixed facility
   Facility Manufacturing
   Product1 Explosives
   Product2
  Transmode
 Transphase
   Pipesite
   Pipetype
   Matnamel Explosives
   Mattypel Explosives
  Minquantl
  Maxquantl
     Units1
   Matname2
   Mattype2
  Minquant2
  Maxquant2
     Units2
   Matname3
   Matname4
   Matname5
   Reltypel Explosion
 Reldetaill
   Reltype2
 Reldetai12
  Mindeaths                6.0000
  Maxdeaths                8.0000
  Mininjury                7.0000
  Maxinjury               12.0000
    Evacnum
     Dammin
     Dammax
    Sources DF,TNO,OECD4,NYT
   Comments Workers killed at an explosives plant (8 PM).
```

as it always hurries to perform a risk analysis and you seldom have the time to wait several days for a response.

The database E X A D A T - which means **EX**-plosives **A**-ccident **DAT**-abase - is:

- available for every risk analyst
- easy to use on a modern PC

It contains and covers (fig. 2) :

- mainly information about accidents during the handling (fabrication, storing, transport, use, destruction) of explosives
- major accidents as well as accidents with very small amounts of explosives
- all types of explosive substances like high explosives, propellants, black powder, pyrotechnics, initial explosives etc.
- accidents as well as incidents and near misses

3. About E X A D A T

3.1 System Requirements

EXADAT (Version 4.0/1996) is an application developed with Microsoft ACCESS 7.0 for WINDOWS 95. To run the database the following computer resources are recommended (fig. 3):

- IBM compatible PC with an installed WINDOWS 95 operating system
- processor 80586 (CPU: Pentium-type)
- 16 MB RAM (32 MB preferred for fast access)
- 20 MB free harddisc space

If you are usually not in a great hurry when running the software, you can also make it with "antique machines" with a 80486-type 66 MHz processor and 8 MB RAM. WINDOWS 95 and a minimum of 10 MB harddisc space are required however.

EXADAT Covers:

- Accidents with explosive substances like:
  - High explosives
  - Propellants
  - Black powder
  - Pyrotechnics

- Accidents during handling like:
  - Fabrication
  - Transport
  - Storing
  - Use

- Major accidents
  Small accidents
  Incidents
  Near misses

Recommended System Requirements:

- **IBM compatible PC**
- **WINDOWS 95 operating system**
- **80586 type processor (Pentium type)**
  (80484 minimum)
- **16 MB RAM (32 MB prefered)**
  (8 MB RAM minimum)
- **20 MB free harddisk space**
  (IO MB minimum)

3.2 Source and Amount of Information

The main sources for the information stored in EXADAT are:

- reports released by the DDESB (US Department of Defence Explosives Safety Board)
- books like "History of Accidents in the Explosives Industry", "History of Explosions"
- reports from the "Institute of the Makers of Explosives"
- personal communication
- newspaper reports

It has to be mentioned that EXADAT does not contain any classified information and does not release any fabrication secrets. Where necessary, sensitive data from the basic sources have been omitted or were modified so that no classification problems arise. In general, the basic accident files are un-classified and may be ordered in case a risk analyst needs more detailed information than contained in EXADAT.

According to our experience, the filling of such a database has to be done by professionals with experience in risk analysis and thorough knowledge of the explosives safety field to get useful results. As this is a time consuming work and the fact that we have only recently started with this work, up to now only about 10 % of our accident files, around 800 reports, have been evaluated and the respective information stored in EXADAT. However, this number is growing fast.

3.3 How are which Data stored?

EXADAT contains - for every event - information on the following main areas (fig. 4):

- General information i.e.
  - Date of accident
  - Time
  - Country
  - Location/City
  - Company

- Event data such as
  - Exact location of event
  - Activity preceding event
  - Involved substances
  - Type of reaction
  - Amount of involved substances
  - Cause of the accident

- Personal injuries
  - Number of death

Main Recorded Data

- Date,
  Time
  Country
  City
  Company

- Place of event
  Activity before event
  Type of explosion
  Amount of explosive
  Cause of accident

- Damage to people

- Damage to material
  Cratering
  Propagation

  - Number of injured

- Damage to material like
  - Total amount of loss
  - Range of window breakage
  - Range of debris throw
  - Crater dimensions

An additional area contains a 400 character text field for remarks and text fields for information about the source of the data.

The data are stored in three different types of data fields:

- **Code-fields** are used to classify the main entries of the database like activity preceding the event, involved substances, cause of the event etc. Figures 5 and 6 give an example of the code list of the explosives. This code system makes it possible to fast and easy retrieve the desired data.

- Each code-field is accompanied by a **text-field** which allows the description of the circumstances in detail.

- The rest of the data, like number of death, size of the crater etc. is stored in **numerical-fields**.

A record of one event contains more than 60 data fields. Therefore EXADAT is one of the most extensive PC databases existing in the explosives safety field. Figure 7 shows a typical output file of one event displaying all the information stored.

EXADAT is a dual language database - German/English - so each text-field exists twice. At this point it has to be mentioned that until now not all text-fields have been translated from German into English. However, the rest of the database, including the complete code lists, the user interface and the menu structure is in English. Therefore, most of the database can be understood and used by English speaking people already now. A entire translation of all text-fields will be done soon.

3.4 How can the Data be Retrieved?

How do we actually use EXADAT? Nothing easier than that. You don't need any special hard- or software knowledge, just start EXADAT. From the "Main Menu" (fig. 8) - containing also such important information like the copyright and information about the limitations of the software - you will choose "Show" (I am sure you will not exit the software yet already). This pops up the screen which allows you the selection of the desired items for your query (fig. 9). You may ask as an example "How many accidents are known in the USA during the melting and casting process of TNT between 1960 and 1980". Every field of this screen can easily be combined in the query. To choose

Example of Codes for Type of Explosives

Main entries:

1000	Explosives
2000	Powders (smokeless)
3000	Black powder
4000	Initial explosives
5000	Pyrotechnics
--	
--	
--	

Example of Codes for Type of Explosives

Sub entries:

1000 Explosives

1100 Nitric Acids

1101 PETN
1102 Nitroglycerine
1103 Nitroglycol
--
--

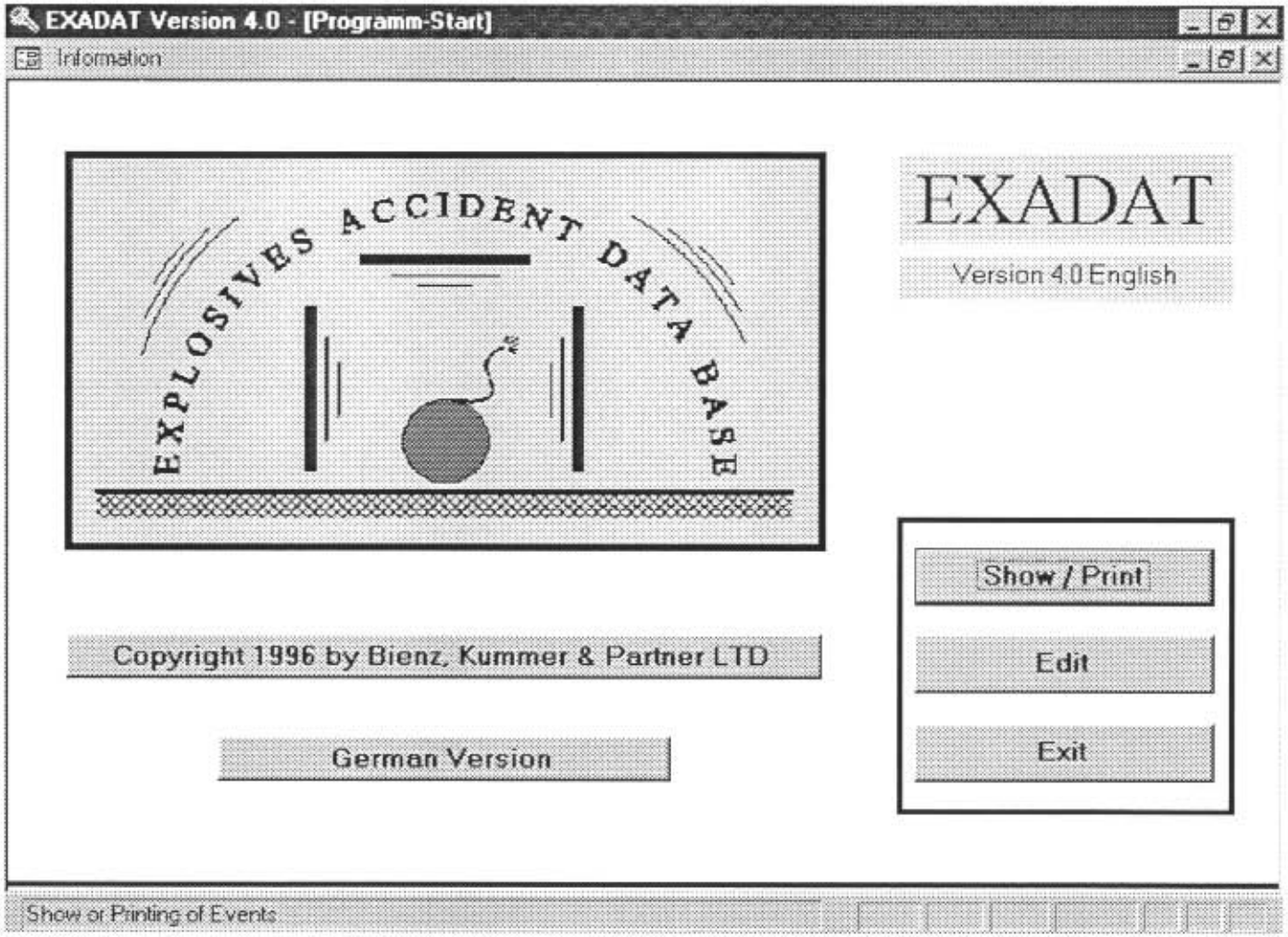
1200 Nitramine explosives

1201 RDX
1202 HMX
--
--

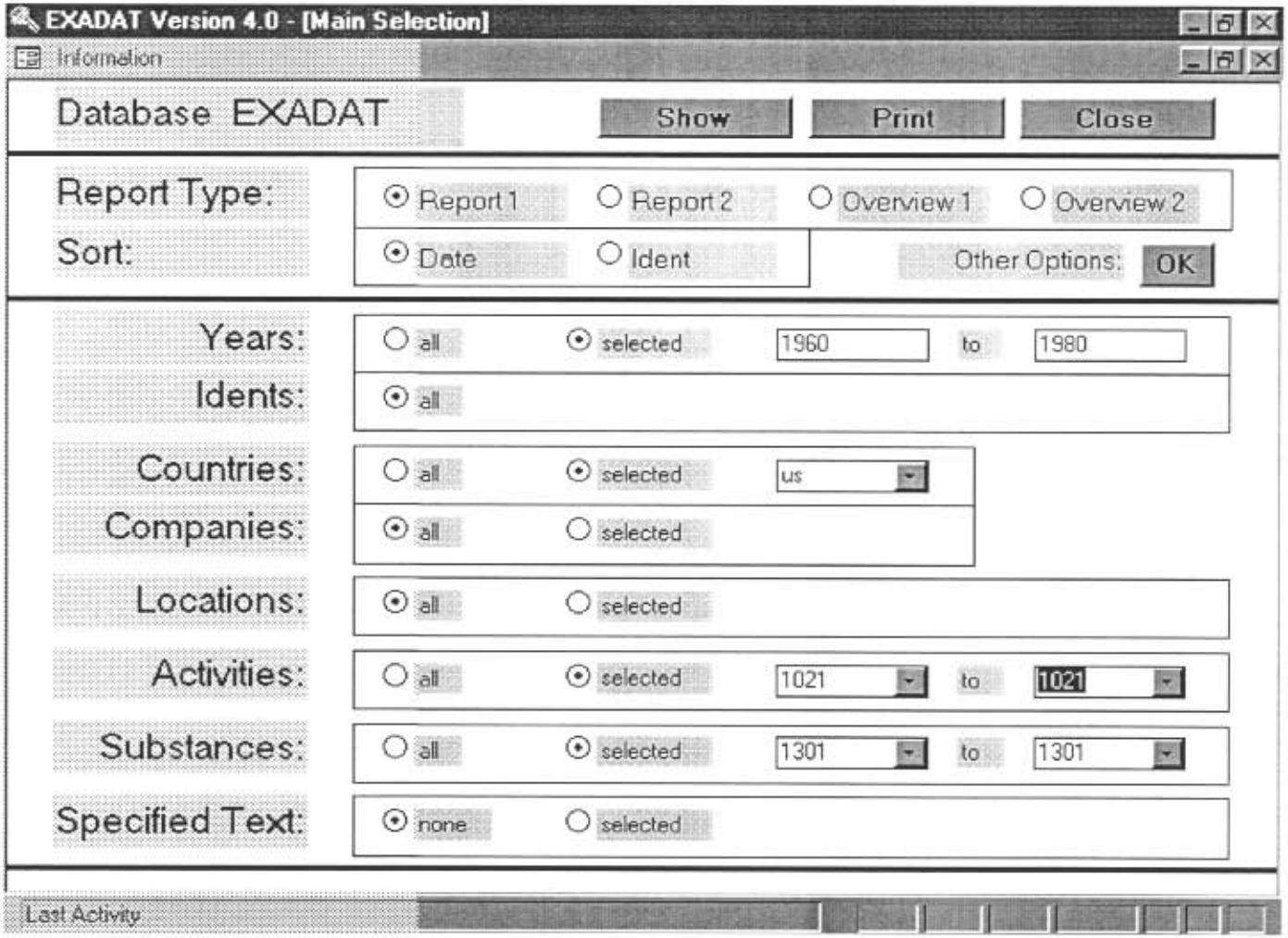
Example of Output

GENERAL INFORMATION:	Date:		11. 01. 1985		Time:		14. 00
	Country:	d	West Germany		Place:		US-Base "Red Leg" near Heilbronn
	Company:	-	US-Army		Responsibility:	M	US-Army
EVENT DATA:	Location:		5040	3010	open place in a US-Army base		
	Activity:		3030. 2		unpacking of a Pershing II rocket motor without war head out of a metal container with a crane		
	Substances:		2040		solid-fuel / propellant HTPB (Ammoniump.)		
	Item:		2050		rocket motor for Pershing II, 1. stage		
	Reaction:		2010		intensive, fast burning fire (2 min)		
	Quantity [kg]:			3'500.0000	about 3500 to 4000 kg		
	Cause:		1311		electro-static discharge because of extreme weather conditions could ignite the rocket motor (confirmed by investigation) --> 1),2)		
PERSONAL INJURIES:	Dead (total / not involved):		3 / 0		Lightly Wounded (total / not involved):		7 / 0
	Injured (total / not involved):		16 / 0		Seriously Wounded (total / not involved):		9 / 0
	Further Details:	N	Remarks:		all dead and injured persons were Americans and suffered serious burns		
DAMAGE TO MATERIAL:	Range of Damage:	K			Crater:	N	Propagation: N
	- Building Destruction [m]:				- Depth [m]:	0.00	- Distance [m]:
	- Window Breakage [m]:				- Diameter [m]:	0.00	- Substance: rocket motor 2. stage
	- Debris Throw [m]:		125.0				
	Amount of Loss [CHF]:				Barricades:	-	
	Further Details:	N	Remarks:		the rocket motor disintegrated partially and "blew" fragments away up to 125 m		
REMARKS:	1) the temperature was extremely cold (-20 C) and the humidity of the air very low 2) obviously the sensitivity of the rocket motor by a temperature of -20 C against electro-static discharge was never tested						
	Source:		Z/U, d,e		Classification:	-	Size: 40.00
	File:		BK&P 12 / 59.3 / 3.2				Evaluation: V

EXADAT Main Menu



EXADAT Select Menu



the proper code number, list boxes can be opened, showing the available codes (fig. 10) so you don't need to know them by heart. Further on, a search for text strings in any text field can be started from here. For queries in data fields not shown on this screen click "Other Options" (fig. 11). This sub-menu allows a selection in every single field of the database. As an example, you can select all accidents with at least 5 death. They will be listed in descending order immediately. However, a query in a field of this sub-menu can actually not be combined with a query in other data fields.

3.5 Which Reports can be made?

The result of a query will be shown either on screen or as a hardcopy. One of three basically different reports can be chosen.

One of the reports shows on one full page all information about one event which is stored in EXADAT, including all the code numbers. Figure 12 shows an example of such a hardcopy. On the screen this report looks not quite the same, however the information content is identical (fig. 13 and 14). The only difference between the output on screen and hardcopy is the one that the latter allows to print - in addition to the code numbers - also the text the code number stands for.

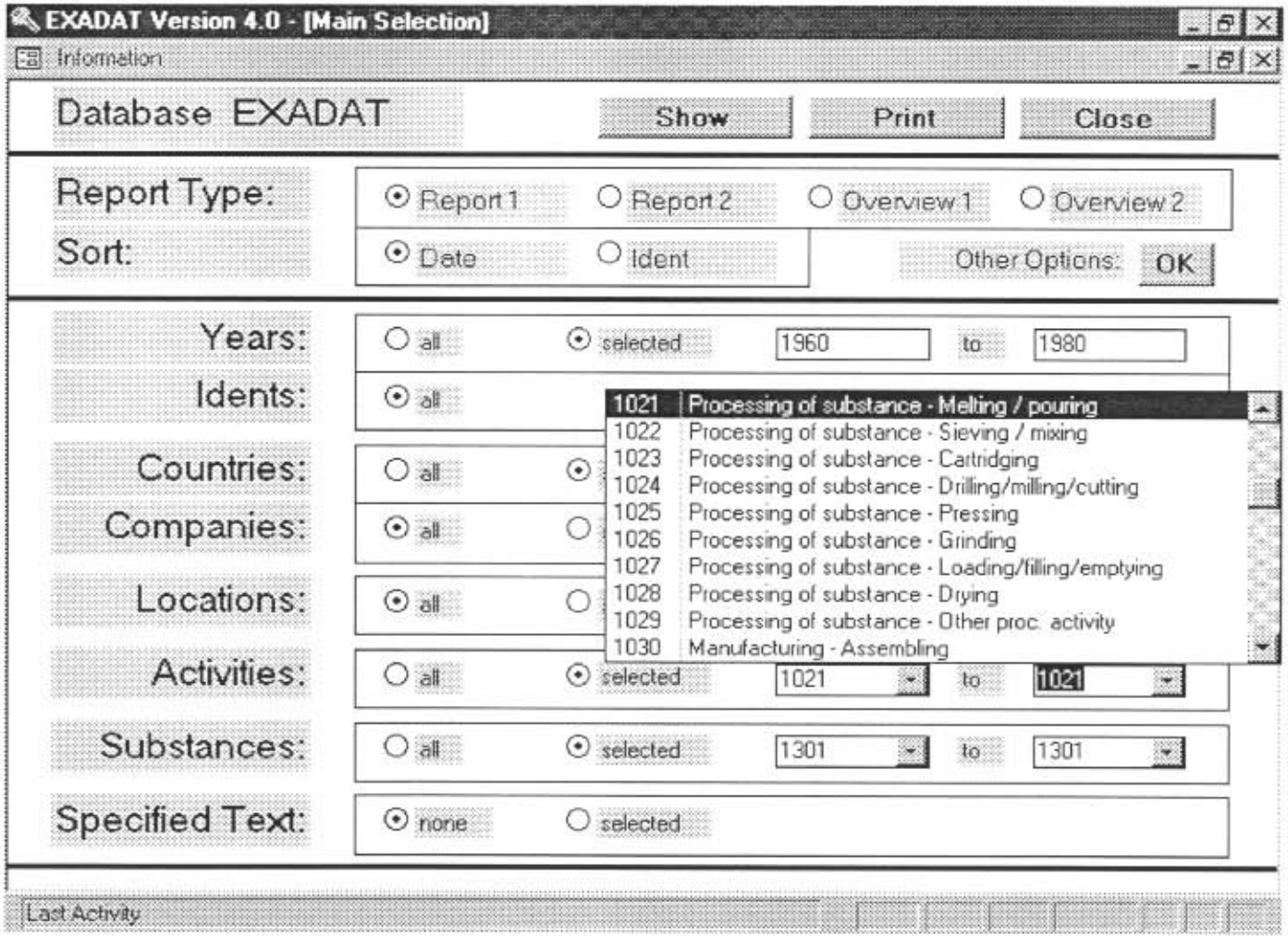
The other two reports are summary reports. One of them concentrating on the display of accidents with personal injuries, the other showing the results of queries concerning involved substances and activities preceding the event. Figures 15 and 16 show the output on screen, figures 17 and 18 show the more or less identical hardcopies. However the screen reports have some additional features. While being in the screen report you can recall full information of an accident just by clicking on "Details", the screen shown in figures 13 and 14 then pops up. Additionally, by clicking on the print option, you can decide if an accident of this list shall appear on the hardcopy or not, making it possible to produce tailormade reports.

4. Future Developments

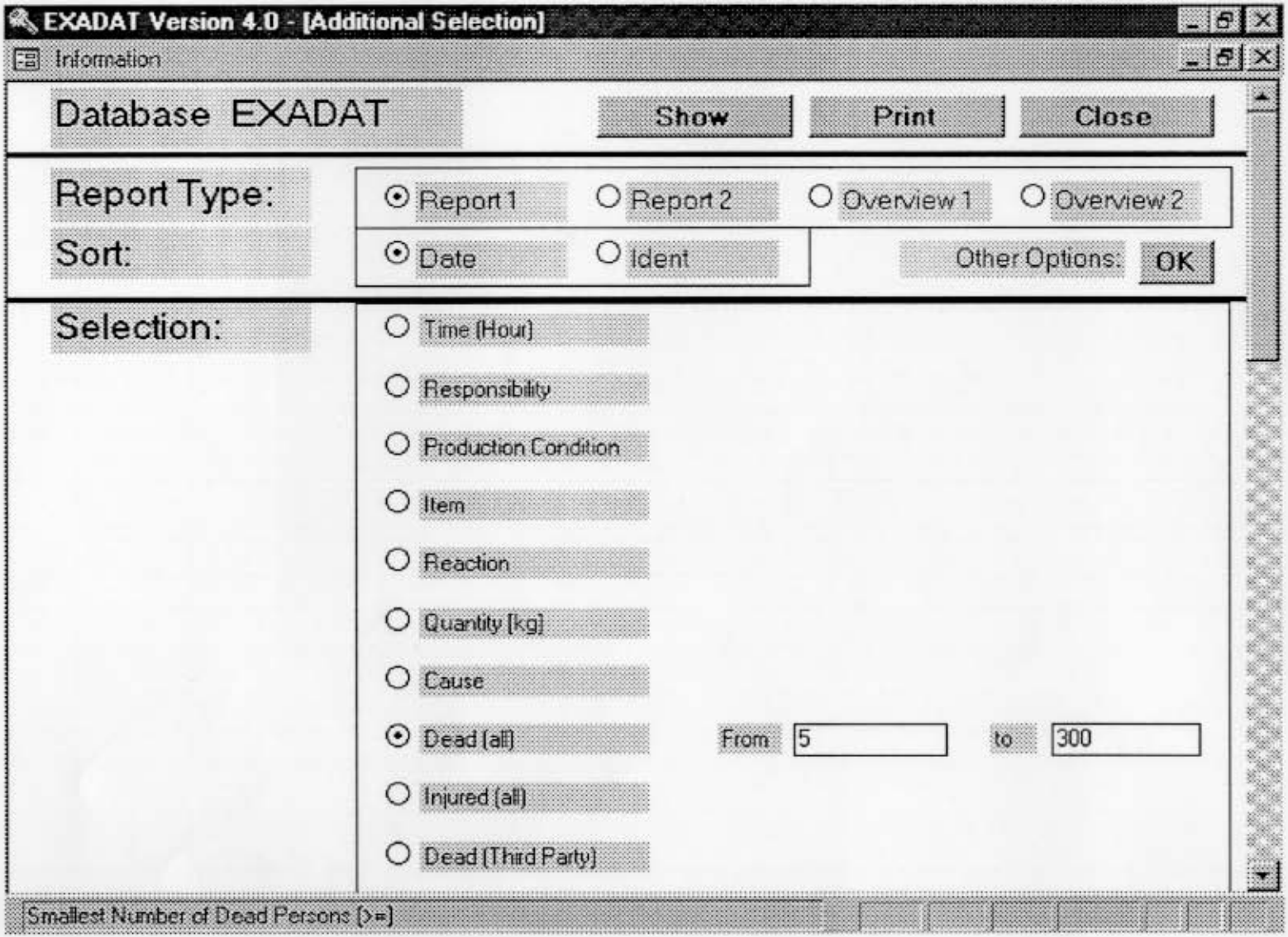
For the moment, our priority is to fill the database with additional events. Depending on the available funds, between several hundred up to thousand accidents reports will be added per year. At the same time a full translation of all text-fields into English is envisaged.

Further on, modules for doing statistics, modules allowing a search in the database with even more complex queries or modules for creating customer made reports may be added. Also the addition of files containing photos and scanned articles will be a topic.

EXADAT Select Menu - List Box



EXADAT Select Menu - Options



EXADAT - Hardcopy of Main Report

DATABASE EXADAT - COMPLETE INFORMATION 2 No. 102

GENERAL INFORMATION:

Date:		11. 01. 1985	Time:		14. 00
Country:	d	West Germany *Federal Republic of Germany*	Place:		US-Base "Red Leg" near Heilbronn
Company:	-	US-Army	Responsibility:	M	US-Army

EVENT DATA:

Location:	5040	*Site of application - Military training area*	open place in a US-Army base
	3010	*Loading / unloading area - Above-ground*	
Activity:	3030. 2	*Transporting - Loading / unloading vehicle* *Regular works (normal conditions)*	unpacking of a Pershing II rocket motor without war head out of a metal container with a crane
Substances:	2040	*Propellant - Solid rocket propellant*	solid-fuel / propellant HTPB (Ammoniump.)
Item:	2050	*Ammunition - Propellant for projectile >35 mm*	rocket motor for Pershing II, 1. stage
Reaction:	2010	*Quick burning fire*	intensive, fast burning fire (2 min)
Quantity [kg]:	3'500.0000		about 3500 to 4000 kg
Cause:	1311	*Cause of event known - Electrostatic discharge*	electro-static discharge because of extreme weather conditions could ignite the rocket motor (confirmed by investigation) --> 1),2)

PERSONAL INJURIES:

Dead (total / not involved):	3 / 0		Lightly Wounded (total / not involved):	7 / 0
Injured (total / not involved):	16 / 0		Seriously Wounded (total / not involved):	9 / 0
Further Details:	N	Remarks:	all dead and injured persons were Americans and suffered serious burns	

DAMAGE TO MATERIAL:

Range of Damage:	K		Crater:	N	Propagation:	N
- Building Destruction [m]:			- Depth [m]:	0.00	- Distance [m]:	
- Window Breakage [m]:			- Diameter [m]:	0.00	- Substance:	rocket motor 2. stage
- Debris Throw [m]:	125.0					
Amount of Loss [CHF]:			Barricades:	-		
Further Details:	N	Remarks:	the rocket motor disintegrated partially and "blew" fragments away up to 125 m			

REMARKS:

1) the temperature was extremely cold (-20 C) and the humidity of the air very low
2) obviously the sensitivity of the rocket motor by a temperature of -20 C against electro-static discharge was never tested

Source:	Z/U, d,e	Classification:	-	Size:	40.00
File:	BK&P 12 / 59.3 / 3.2			Evaluation:	V

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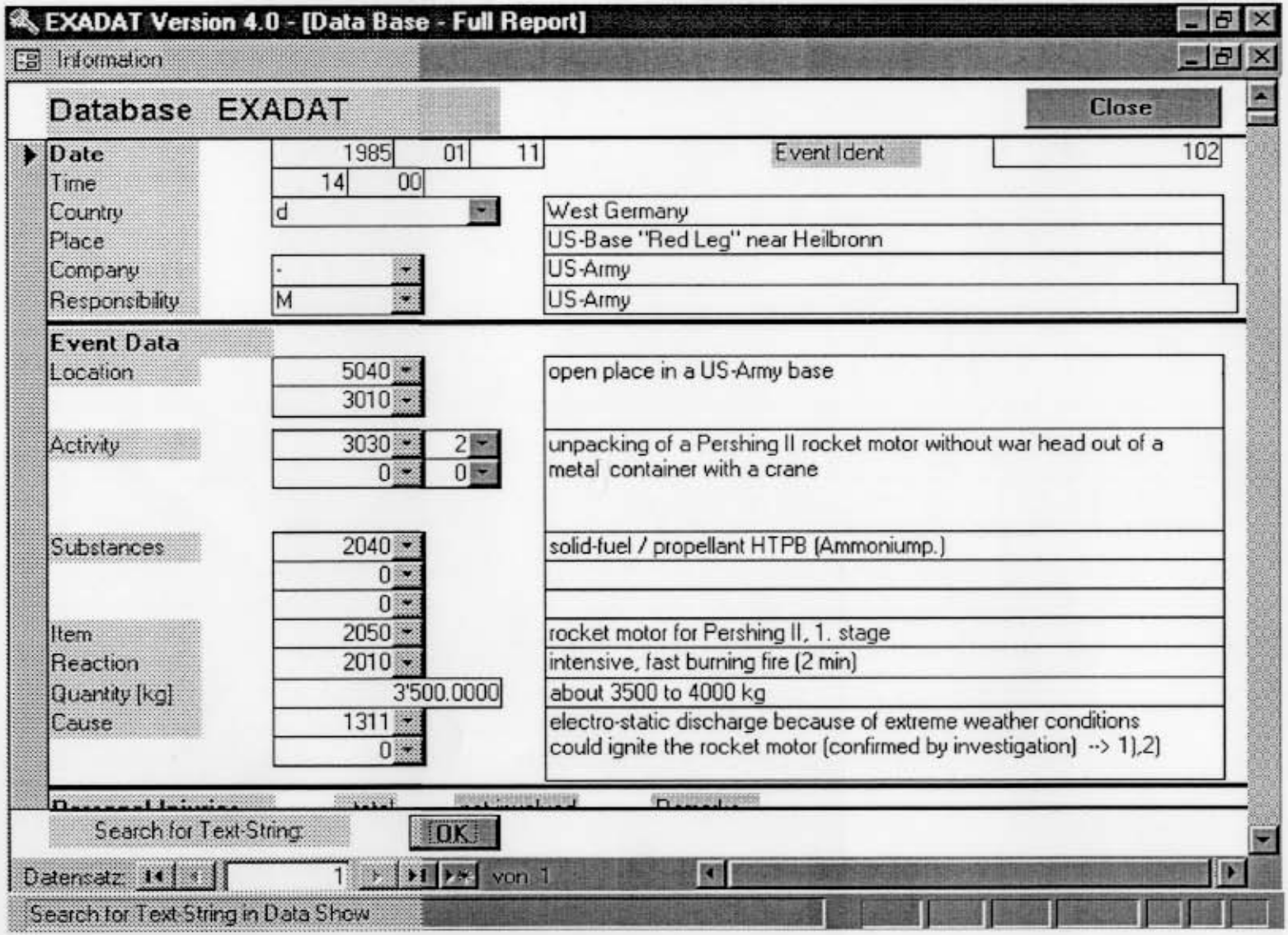
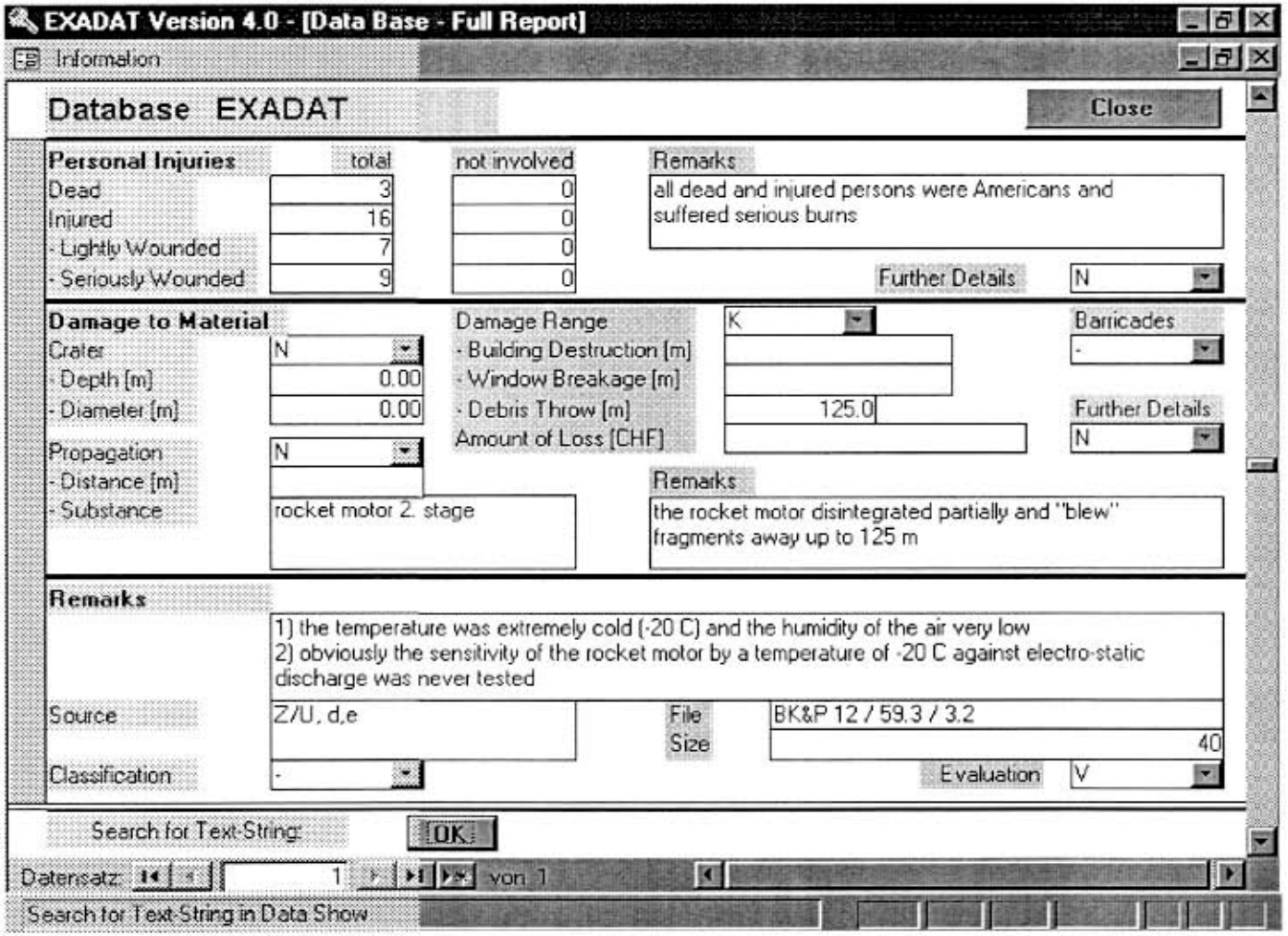
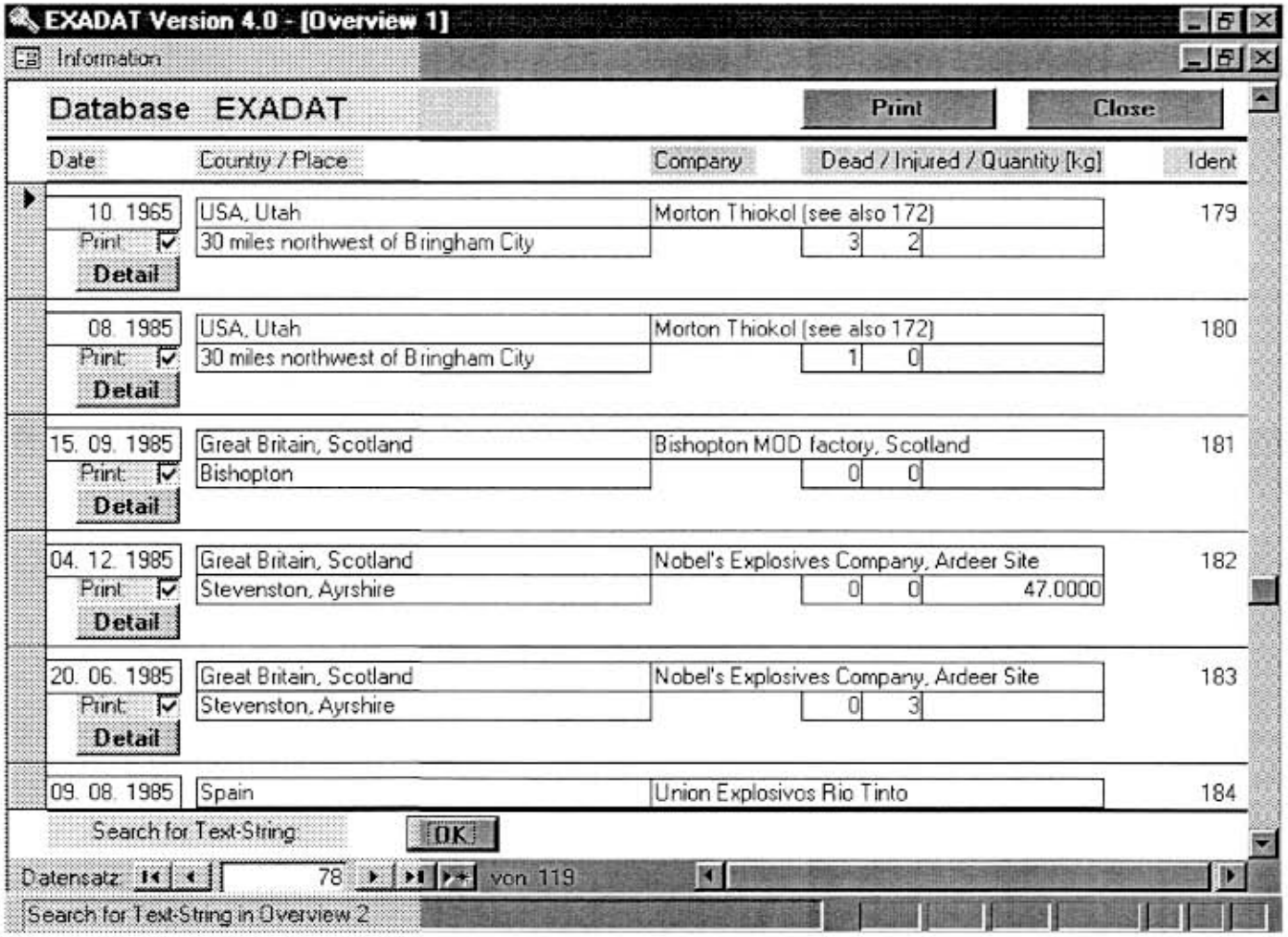
EXADAT - Screen Main Report (Part 1)



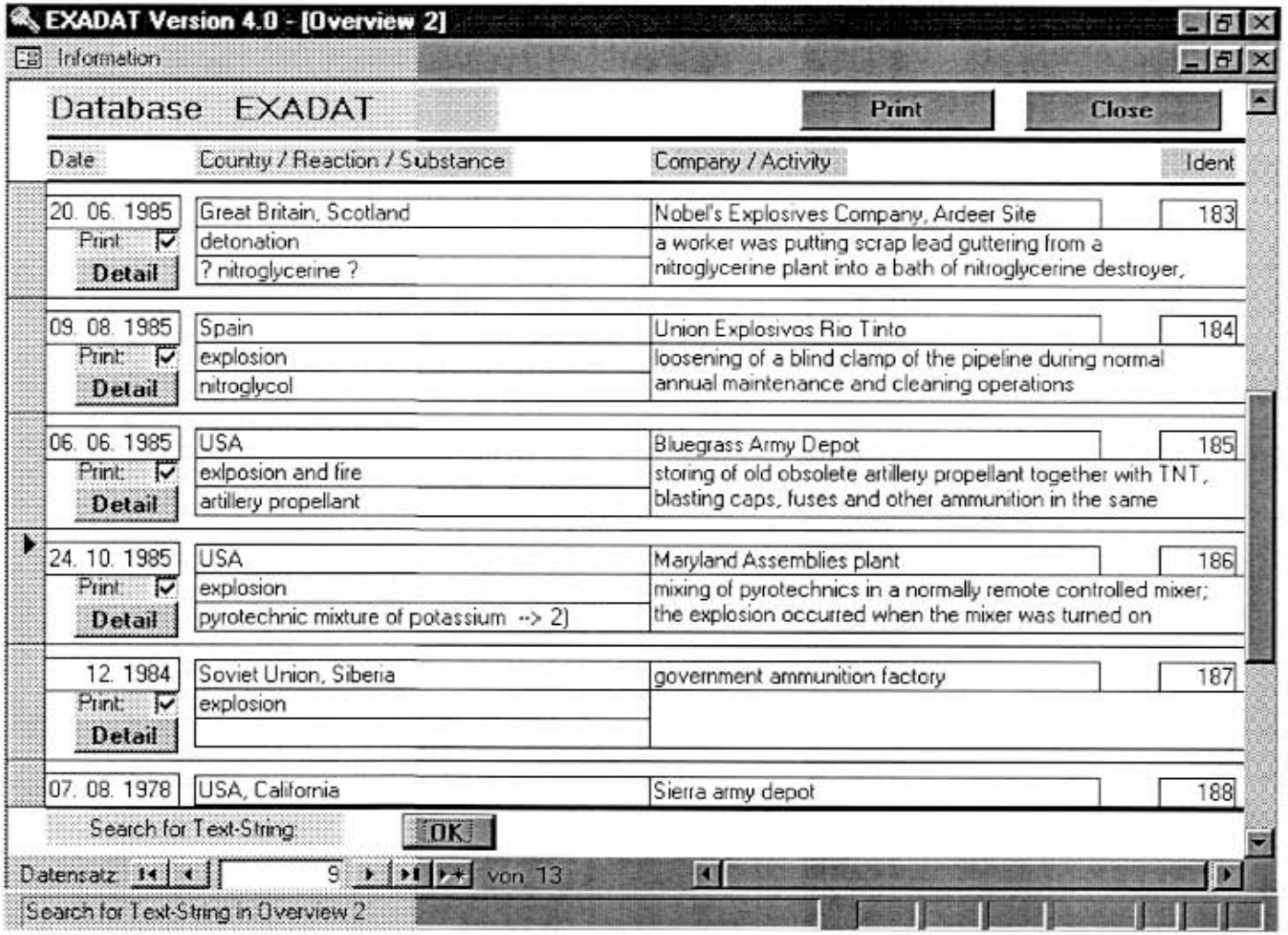
EXADAT - Screen Main Report (Part 2)



EXADAT - Screen Summary Report 1



EXADAT - Screen Summary Report 2



EXADAT - Hardcopy of Summary Report 1

DATABASE EXADAT - OVERVIEW 1 Page: 1

Date	Country	Place	Company	Dead	Injured	Quantity [kg]	Ident
02. 03. 1984	USA, Utah	30 miles northwest of Bringham City	Morton Thiokol (see also 172)	0	14	90'000.0000	178
10. 1965	USA, Utah	30 miles northwest of Bringham City	Morton Thiokol (see also 172)	3	2		179
08. 1985	USA, Utah	30 miles northwest of Bringham City	Morton Thiokol (see also 172)	1	0		180
15. 09. 1985	Great Britain, Scotland	Bishopton	Bishopton MOD factory, Scotland	0	0		181
04. 12. 1985	Great Britain, Scotland	Stevenston, Ayrshire	Nobel's Explosives Company, Ardeer Site	0	0	47.0000	182
20. 06. 1985	Great Britain, Scotland	Stevenston, Ayrshire	Nobel's Explosives Company, Ardeer Site	0	3		183
09. 08. 1985	Spain	Paramo de Masa, Burgos	Union Explosivos Rio Tinto	1	1		184
06. 06. 1985	USA	Berea	Bluegrass Army Depot	0	0		185
24. 10. 1985	USA	Perry near Tallahassee	Maryland Assemblies plant	1	1		186
12. 1984	Soviet Union, Siberia	Leninsk-Kuznetski near Novosibirsk	government ammunition factory	300			187
07. 08. 1978	USA, California	Herlong	Sierra army depot	0	0	63'000.0000	188
03. 07. 1983	USA, Louisiana		Fort Polk (US Army)				189
08. 1985	USA, Arizona	Yuma	Air Force Base				190

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EXADAT - Hardcopy of Summary Report 2

DATABASE EXADAT - OVERVIEW 2 Page: 1

Date	Country / Company	Reaction / Substance	Activity	Ident
15. 09. 1985	Great Britain, Scotland Bishopton MOD factory, Scotland	explosion ? nitroglycerine ?	?storing of nitroglycerine?, at the time of the explosion (evening) the plant was not in operation	181
04. 12. 1985	Great Britain, Scotland Nobel's Explosives Company, Ardeer Site	deflagration nitrocellulose + --> 1)	mixing of several chemicals and nitrocellulose in an incorporator (mixer)	182
20. 06. 1985	Great Britain, Scotland Nobel's Explosives Company, Ardeer Site	detonation ? nitroglycerine ?	a worker was putting scrap lead guttering from a nitroglycerine plant into a bath of nitroglycerine destroyer, one piece --> 1)	183
09. 08. 1985	Spain Union Explosivos Rio Tinto	explosion nitroglycol	loosening of a blind clamp of the pipeline during normal annual maintenance and cleaning operations	184
06. 06. 1985	USA Bluegrass Army Depot	exlposion and fire artillery propellant	storing of old obsolete artillery propellant together with TNT, blasting caps, fuses and other ammunition in the same magazine	185
24. 10. 1985	USA Maryland Assemblies plant	explosion pyrotechnic mixture of potassium --> 2)	mixing of pyrotechnics in a normally remote controlled mixer; the explosion occurred when the mixer was turned on	186
12. 1984	Soviet Union, Siberia government ammunition factory	explosion		187
07. 08. 1978	USA, California Sierra army depot	detonation of 10 BLU-82/B simultaneously Slurry explosive, containing aluminium	storing of 30 BLU-82/B (--> 1)) in open storage site for 7 years; no operations were in progress and no personnel present	188
03. 07. 1983	USA, Louisiana Fort Polk (US Army)	fire Slurry explosive	storing of explosives and small arms ammunition in a magazine	189
08. 1985	USA, Arizona Air Force Base	fire (accidental) aluminized nitrate slurry	? storing of a slurry explosive ?	190

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5. Final Remarks

When doing risk analysis in the explosives safety field, a fundamental requirement is the having of data on hand about accidents which already have happened. Nobody would accept an accident to happen twice the same way, only because the information about the first occurrence was not available and the lessons could therefore not be learned in time.

The perfect instrument and source of basic data for a risk analyst in the field of explosives safety is EXADAT. EXADAT is (figure 19):

- runs on PC,
- easy to use,
- contains all types of accidents and incidents in the explosives field and
- helps you to reduce the number of accidents in the future.

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   Peter O. Kummer, Andreas F. Bienz for Bienz, Kummer & Partner Ltd.
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   Paper presented at the 23th DDESB Seminar 1988 in Atlanta/GA

Main Advantages of EXADAT

- Contains accidents and incidents, big ones and small ones with explosives
- Easy to use
- Runs on PC
- Helps to enhance safety